be the tracing-point and the pencil of a pentagraph. You may with the first point draw any figure you please: there will be a corresponding figure drawn by the second point, — for a good pentagraph, a copy on a scale different, it may be; for a badly adjusted pentagraph, a distorted copy; but the one figure will always be a sort of copy of the first, so that to each point of the one figure there will correspond a point in the other figure.

In the case above referred to, where one point represents the value $x+iy$ of the imaginary variable, and the other the value $X+iY$ of some function, $\phi(x+iy)$, of that variable, there is a remarkable relation between the two figures: this is the relation of orthomorphic projection, the same which presents itself between a portion of the earth's surface and the representation thereof by a map on the stereographic projection or on Mercator's projection; viz., any indefinitely small area of the one figure is represented in the other figure by an indefinitely small area of the same shape. There will possibly be for different parts of the figure great variations of scale, but the shape will be unaltered. If for the one area the boundary is a circle, then for the other area the boundary will be a circle: if for one it is an equilateral triangle, then for the other it will be an equilateral triangle.

I have been speaking of an imaginary variable $(x+iy)$, and of a function, $\phi(x+iy)=X+iY$, of that variable; but the theory may equally well be stated in regard to a plane curve: in fact, the $x+iy$ and the $X+iY$ are two imaginary variables connected by an equation. Say their values are u and v, connected by an equation, $F(u, v) = 0$: then, regarding u, v, as the co-ordinates of a point *in plano*, this will be a point on the curve represented by the equation. The curve, in the widest sense of the expression, is the whole series of points, real or imaginary, the co-ordinates of which satisfy the equation; and these are exhibited by the foregoing corresponding figures in two planes. But, in the ordinary sense, the curve is the series of real points, with co-ordinates u, v, which satisfy the equation.

In geometry it is the curve, whether defined by means of its equation or in any other manner, which is the subject for contemplation and study. But we also use the curve as a representation of its equation; that is, of the relation existing between two magnitudes, x, y, which are taken as the co-ordinates of a point on the curve. Such employment of a curve for all sorts of purposes — the fluctuations of the barometer, the Cambridge boat-races, or the funds — is familiar to most of you. It is in like manner convenient in analysis, for exhibiting the relations between any three magnitudes, x, y, z, to regard them as the co-ordinates of a point in space; and, on the like ground, we should at least wish to regard any four or more magnitudes as the co-ordinates of a point in space of a corresponding number of dimensions. Starting with the hypothesis of such a space, and of points therein, each determined by means of its co-ordinates, it is found possible to establish a system of n-dimensional geometry analogous in every respect to our two- and three-dimensional geometries, and to a very considerable extent serving to exhibit the relations of the variables.

It is to be borne in mind that the space, whatever its dimensionality may be, must always be regarded as an imaginary or complex space, such as the two- or three-dimensional space of ordinary geometry. The advantages of the representation would otherwise altogether fail to be obtained.

I omit some farther developments in regard to geometry, and all that I have written as to the connection of mathematics with the notion of time.

(To be continued.)

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

STATE INSTITUTIONS.

Illinois state laboratory of natural history, Normal, Ill.

Experiments with diseased caterpillars. — Prof. S. A. Forbes is making a special study of 'schlaffsucht,' or some very similar disease, among our native caterpillars. He has so far proven that the disease is characterized by an enormous development of bacteria in the alimentary canal, the same forms appearing in the blood before death; that it is contagious by way of the food ingested; that the characteristic bacteria may be easily and rapidly cultivated in sterilized beef-broth; and that caterpillars whose food has been moistened with this infected broth, speedily show the bacteria in the alimentary canal, and, later, in the blood, and soon all die of the disease. Other caterpillars of the same lot, receiving the same treatment, except that the food is moistened with distilled water instead of the infected broth, remain unaffected. These bacteria are likewise cultivable in vegetable infusions, but multiply there less freely.

Every step of the investigation is fortified by stained and mounted preparations, which are being submitted to cryptogamists. It has already been determined that the bacterium infesting a brood of Datana ministra in his breeding-cages is identical with the Micrococcus bombycis of the silk-worm; the form, measurements, modes of aggregation, and behavior to reagents, of the two, being the same. Datana Angusii, feeding upon walnut, was also occasionally infested by this M. bombycis, but much more commonly by a spherical species, probably undescribed.

In the cabbage-worm (Pieris rapae) occurs still another species of Micrococcus, very minute (5 μ in diameter), globular, and usually either single or in pairs. This is far the most virulent of the insect affections, which is being studied by Forbes, — the

most like a plague. In its earlier stages it can usually be recognized by the light tint of the larvae, an ashy green, so different from the ordinary color that one may pick out the diseased worms at a glance. These soon become torpid, and commonly die in a few hours. After death, decomposition is peculiarly sudden and rapid. A pale individual, picked out in the evening while still active, at eight o'clock the following morning was dead, blackened, and almost deliquescent, the whole body being reduced to a semi-fluid condition. This Micrococcus multiplies rapidly in beef-broth, rendering the fluid turbid.

The cultures of these Micrococci are made by the most rigorous use of the modern methods of 'pure culture.'

Only M. bombycis has thus far been successfully used by Forbes for the infection of healthy larvae; but experiments with the other species are now in progress. Measures are also being taken to learn the length of life of these bacteria when kept in hermetically-sealed tubes, with the expectation that this will furnish a means of preserving and transporting them for practical use, if this should prove to be worth while.

Forbes is also experimenting with the various ferment-germs appearing spontaneously in organic infusions, and has noted the occasional appearance of large numbers of Saccharomyces in the intestines of unhealthy larvae, and of those whose food has been treated with fermenting vegetable infusions.

NOTES AND NEWS.

We deeply regret to announce the death of Dr. Hermann Müller, on Aug. 25. Next to Darwin, Müller has done the most to advance our knowledge of the mutual relations between plants and animals in one of its many phases. Some notice of his life and work will be given in a future number.

— The boundary-line between Guatemala and Mexico, which, as we announced last week, Mr. Miles Rock has been commissioned to locate, is about two hundred miles in length; and one or two years will be required to finish the work. Astronomical stations will be established along the line, and topographical and profile maps will be made to extend as far as time and means will permit. If possible, the longitude of Guatemala City will be determined telegraphically by connecting with some point on the coast occupied by the U. S. hydrographic party under Lieut.-Commander Davis.

Mr. Rock has also been commissioned by the Smithsonian institution to collect notes on anthropology in the country over which his survey extends, and to photograph whatever archeological ruins he may meet with during the progress of the survey. He sailed from New York on Oct. 1, in the steamer Acapulco.

— The annual report of the librarian of the public library of Cincinnati for the year ending June, 1883, has just been issued. The total number of volumes and pamphlets in the library is 149,750. "The average number of books loaned daily for home use has been 680. The average number delivered for use in the reading-room has been 379 per day." In tables showing the number of books issued for home use and for consultation are given percentages for various classes. Fiction heads the list with 81.4% in books for home use, and 28.3% in the reading-room. Science and arts are represented by only 2.9% for home use, but rise to 24.8% for books consulted at the library. The number of volumes of fiction circulated during the year was 167,678, and of science and arts only 5,928. In the consulting-room, however, 39,539 volumes of fiction were issued, and 33,916 volumes in science and arts. Though these figures show a marked preponderance in the circulation of fiction over science and arts, as indeed they do over every other class, the preponderance is perhaps more apparent than real. As the librarian says in his report, these percentages are often misleading. "They lead the public to believe that a much larger than a true proportion of the work of a library is in the distribution of books calculated to entertain rather than to instruct. Probably not more than one-sixth of the time devoted to a volume of history or of science is devoted to a novel by the average reader; and yet in these figures volumes of history and science count equally with volumes of fiction and juvenile literature."

In a table 'showing the number and the classes of books used during each month of the year,' we find some interesting figures. More books were used during the months of January and March than during any other two months of the year. In philology there was nearly a regular increase from month to month from July to January, and a decrease to June. In history, from 1,387 volumes in December, there was an increase to 1,818 in January, decrease to 1,385 in February, and increase again to 1,586 and 1,581 in March and April respectively. In geography and travels, March takes the lead with 1,006. In science and arts the increase is regular from July (2,558) to January (4,656), when the decrease commences; and in June we have 2,838. In the totals we find that nearly 40% of the books were used during the months of December, January, February, and March; while only about 28% were used during June, July, August, and September.

— The latest news from the French deep-sea explorations on the Talisman is comprised in a letter from M. Alph. Milne-Edwards, at Teneriffe. Every thing had worked in a satisfactory manner. Many soundings had been made off the coast of Morocco, and interesting profiles of the bottom thereby developed. Bottom and water specimens were simultaneously obtained, and the work was even carried on at night by the aid of electric lights. Considerable zoölogical collections had been made, and the professor was especially devoting himself to the study of their distribution in depth. The character of the fauna already enabled a tolerable estimation of the depth to be made from an examination of the animals contained in any particular haul of the dredge. By the use of extremely large nets, better luck had been secured in the capture of deep-sea fishes than had